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A NEW TECHNIQUE FOR TESTING MOLTEN PLUTONIUM CONTAINER
MATERIALS AT HIGH TEMPERATURE*

MASTER

by

R. L. Andelin, A. R. Hawkins, and N. G. Wilson

University of California
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

SUMMARY

This paper was submitted for publication in the open literature at least 6 months prior to the issuance date of this Microcard. Since the U.S.A.E.C. has no evidence that it has been published, the paper is being distributed in Microcard form as a preprint.

In January, 1964, a program was initiated in the Power Reactor Division at Los Alamos to develop a method for high-temperature compatibility testing of molten plutonium fuels with container materials. The objective of high-temperature testing is to accelerate plutonium penetration through the container wall, and thus shorten the time required to obtain corrosion information. The method developed does greatly decrease the time required to obtain corrosion information over conventional capsule testing in isothermal sodium loops. Tests may be conducted at temperatures between 900° and 1200°C, and the exact time of failure is determined.

The technique is to continuously monitor a short fuel capsule (heated in vacuo) with water-cooled, silicon surface-barrier detectors. The capsule is heated inside an evacuated quartz tube assembly (Fig. 1) by a resistance-type tube furnace (not shown) which fits around the reduced diameter section of the quartz tube. The bottom detector head is attached to a 4-inch vacuum diffusion pump which provides a chamber pressure, at temperature, in the low 10^{-7} torr range. Each water-cooled detector head houses three alpha particle detectors which are thermally shielded by thin

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R. L. Andelin

Fig. 1

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nickel foils inside the head, and by external thermal radiation shields. Details of the detector heads, and the instrumentation required for the alpha particle detection system are described elsewhere.¹ The entire system is completely automated; an attendant need not be present during testing. When approximately one microgram of plutonium penetrates the wall of a capsule in test, the fuel is rapidly quenched, and the experiment is shut down.

The results of preliminary tests with a 97.5 w/o plutonium - 2.5 w/o iron - gallium stabilized fuel alloy contained in pure tantalum capsules are shown in Fig. 2. The data for the 700°C point were obtained from isothermal sodium loop tests. The linear relationship shown is evidence for a constant penetration mechanism, and illustrates the validity, for this system, of extrapolating high-temperature test data to lower temperatures more practical for reactor operation. For the Pu-Fe-Ga system, intergranular penetration is the failure mechanism; the process is thought to be grain-boundary diffusion controlled.

References

1. B. M. Moore, et al., "Detection of Plutonium Penetration through Containers at High Temperatures," Trans. Am. Nucl. Soc., Eleventh Annual Meeting, June 21-24 (1965).

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Fig. 2

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Figure captions:

Fig. 1. Quartz Tube Assembly.

Fig. 2. Temperature Dependence of Capsule Lifetime for the System
97.5 w/o Pu - 2.5 w/o Fe - Ga Stabilized Fuel Contained in
Ta Capsules.